From an examination of the few specimens in the collections I have had access to, Schiner's remarks appear correct, but the drawing of the genitalia of *D. cupreus* by Loew is probably not very correct—it does not represent the genitalia of *D. chalcogaster* accurately.

Walker's *D. phœax* appears to be identical with this species, but the type is in very bad condition, from S. Africa (*Dr. Smith*), 44, 6.

Dysmachus chalcogaster, Wied.

Zool. Mag. i. pp. 3, 35, 50 [*Asilus*] (1819); id. Dipt. Exot. p. 189, 13 [*Asilus*] (1821); id. Ausszweifl. Ins. i. p. 442, 26 [*Asilus*]; Schiner, Verh. zool.-bot. Ges. Wien, xvi. p. 684, 26 [*Lophonotus*]; id. xvii. p. 401. 101 [*Lophonotus*] (1867).

Dysmachus cupreus, Loew, Dipt. Südafrik. i. p. 154, 2, pl. ii. fig. 5 (1860).

There do not appear to be any specimens of this species in the Brit. Mus. Coll., but in the Cape Mus. Coll. are a male and two females from Cape Colony answering to the description as given by Wiedemann and Schiner. It has a golden-yellow moustache, with black bristles at the sides and above. Schiner gives the genitalia as long and club-shaped, the forceps bifid. The above specimens measure 23–27 mm.; Wiedemann gives 16 mm.

[To be continued.]

XXXI.—*On some Freshwater Fossils from Central South Africa.* By R. Bullen Newton, F.G.S.

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[Plate VIII.]

Introduction.

This communication deals with an enquiry into the history of certain obscure freshwater fossils occurring in a highly siliceous rock from Africa, the important outcome of which is in respect of their geological age. In this connexion, therefore, I have had referred to me for determination three hand-specimens of a chalcedonized rock containing fossils, which have been discovered by Mr. A. J. C. Molyneux, F.G.S., in the Matabeleland region of Central South Africa.

They were forwarded by Dr. G. Arnold, Curator of the Rhodesia Museum, with the following remarks from Mr. H. B. Maufe, B.A., F.G.S., Director of the Geological Survey of Rhodesia:—"The Chalcedony in which the Gastropods and Plant-remains discovered by Mr. A. J. C. Molyneux occur, is found at the base of the Kalahari Sand, which is widely spread in Northern Matabeleland. No other fossils are known from these beds. They lie on a peneplain eroded in Upper Karroo Beds and are older than the present river-system. The peneplain is younger than the Kimberlite pipes, supposed to be Upper Cretaceous, but any evidence of age from palæontological data would be most valuable." An examination of these rocks proved them to be completely silicified, having the appearance of a flint within and possessing a similar conchoidal fracture. Externally two of the specimens are of a rough sandstone character of reddish brown or straw-colour, due possibly to weathering by exposure, while the third example is of similar reddish colour but much smoother, having been probably subjected to some kind of erosion. From a study of the organisms, which comprise small Gastropods resembling *Viviparus* and *Paludestrina*, and plant-remains belonging to the genus *Chara*, there is no doubt as to the freshwater origin of this deposit and its representing a relic of an ancient fluvio-lacustrine bed or a former region of marsh-land. The more prominent fossils are restricted to the surface, although microscopical sections of the flinty matrix indicate their existence throughout the rock, but in a distinctly more comminuted state. It should be noted also that the *Chara* remains are quite abundant, whereas the shells are of rarer occurrence.

Description of the Fossils.

The rocks, which are numbered 1350, 1351, and 1352, may have their fossils thus briefly described:—

Rock no. 1350.—This contains several fruits of *Chara* of minute size bearing extremely fine spiral striations, which are arranged longitudinally in tufts of two or more at slightly distant intervals, being sometimes represented by cavities in which the fruits have disappeared, although leaving behind as mural impressions the familiar markings of their external conformation (Pl. VIII. fig. 6). The surface of this rock is rather eroded, being smoother than the others, which renders the stem-structures of the *Chara* too obscure for definition, although they appear to be wider than those associated with specimen no. 1352. There are scarcely any indications of Gastropod remains in this rock.

Locality. S. side of Shangani River flats on road to Lubu (Bubi District).

Rock no. 1351.—Near the margin of a central depression in this rock is a crowded group of minute *Chara*-stems of smaller diameter than those represented in no. 1352. In close proximity is a well-preserved oval fruit of medium size as well as fruit-cavities of minute size; obscure Gastropod remains are also present, but too indefinite for identification (Pl. VIII. fig. 2). Similar structures are also displayed in a microscopical section of this rock, especially a stem-section cut transversely, exhibiting about fourteen minute tubular apertures surrounding a moderately wide central canal (Pl. VIII. fig. 7).

Locality. N. flank of Kana Valley on road to Lubu (Sebungwe District).

Rock no. 1352.—On the surface of this rock are displayed some narrow, fragmentary, flattened stems of *Chara* (Pl. VIII. fig. 4), less than a millimetre in diameter, bearing the equidistant, longitudinal, rounded ridges and furrows characteristic of that genus; the stems also exhibit a system of branching with obscure thickenings at the joints, while at their exposed transverse ends are indications of the central tube and surrounding minor tubes or cells which are so typical of *Chara* morphology. No fruits are directly associated with the stems, although there is a large, rather coarse, and spirally ridged ovate body lodged in a small cavity quite close to some stem-fragments, which represents an *oogonium* or fruit (Pl. VIII. fig. 5). Besides the plant-remains are some minute Gastropods with faint longitudinal striations, too obscure for determination, although the larger form, measuring 3 mm. in height and diameter, with a wide base and short conical spire, belongs to *Viviparus* (Pl. VIII. fig. 1 *a*), while another with an elongate spire and a more or less cylindrical axis, measuring 2·5 mm. in height and less than 1 mm. in diameter, may be a *Paludestrina* (Pl. VIII. fig. 1 *b*). There is another and somewhat different Paludestriniform shell on the surface of this rock of rather similar dimensions, giving a fairly complete dorsal outline (Pl. VIII. fig. 3) with a lengthy spire. These specimens exhibit no internal characters of the aperture, being firmly embedded in the siliceous matrix and yielding only dorsal views.

Locality. Kana Umzola, N. flank of Kana Valley on road to Lubu (Sebungwe District).

My grateful thanks are due for the following additional and more technical notes on the Charophyte-remains contained in these rocks, which have been kindly drawn up by Mr. James Groves, F.L.S., one of our chief authorities on the morphology of recent Characeous Plants :—

Rock no. 1350.—This shows what is probably an oospore with a dark margin representing a section of the enclosing spiral cells which constitute the oogonium-sac. It is of small dimensions, being about ·45 × ·35 mm. The spaces between the spiral lines are somewhat convex, although this may be due to being chalcedonized. The outline of the margin corresponds roughly with the impressions of associated oogonia measuring ·775 × ·525 mm. There is another supposed oogonium or a larger oospore about two-fifths of which is exposed, having a definite surrounding margin of dark mineralized matter and showing a diameter of ·425 mm. The crushed oogonium (or oospore) in close proximity has, apparently, a much tapered base (Pl. VIII. fig. 6).

Rock no. 1351.—Contains a large oogonium, which, on account of its size, would be a different species to that seen in no. 1350. It is probably 1 × ·6 mm. The branchlets near by are about ·26–·3 mm. in diameter. A microscopical slide cut from this rock exhibits a good diagonal section of a branchlet (or small stem) with a diameter of about ·4 mm. and possessing a probable diplostichous cortex, as it consists of about fourteen cells in section (Pl. VIII. fig. 7). Certain small cylinders, considered to be bract-cells, show a diameter of about ·2–·3 mm., but no branchlet-node was observed. Another stem or branchlet section gives a diameter of about ·6 mm. A further microscopical slide shows a good transverse section of stem with a diameter (including cortex) of about ·45 mm. The cortex is almost certainly diplostichous, cells fourteen and of nearly equal diameter (·03 mm.). The smaller ecorticate sections may be both branchlets and bract-cells, although, from their position, there is no indication of whorls.

Rock no. 1352.—The *Chara* remains on the surface of this specimen belonged probably to a medium-sized plant of about the stature of the living *Chara vulgaris*.

Stem moderately stout, about ·65–·90 mm. in diameter. Cortex triplostichous, rather irregular, primary series sometimes much the larger, but secondary cells of varying diameter. No cortex nodes determinable.

Whorls of about eight branchlets. Branchlets from about ·25–·4 mm. in diameter, fully corticato-cortex diplostichous. Points of meeting of upward series well shown. No branchlet nodes apparent.

Stipulodes doubtful whether haplostephanous or diplostephanous, only one series seen, bistipulate. Two well-developed, cylindrical, acuminate stipulodes clearly shown, directed upwards, which are on the stem node.

Fruit about ·75 mm. in length and about ·45 mm. in diameter (Pl. VIII. fig. 5). Spiral cells showing about thirteen convolutions. Apparently a full-grown fruit, somewhat crushed in the upper part. A microscopical preparation of this rock exhibits a good median section of an oogonium with the oospore outlined therein. Dimensions of the oogonium about 1·125 mm. long and ·7 mm. broad. Convolutions apparently from twelve to thirteen, but these can only be estimated, as the cells are obscure at both ends. Dimensions of oospore (probably shrunken) about ·70 mm. long and ·35 mm. broad. In size of oogonium and number of convolutions this corresponds approximately to *Chara hispida* among living species. There are several good transverse sections of stems about ·4 mm. thick, the cortex evidently diplostichous, the number of cells being about fourteen, and the alternation of primary and secondary series being in some cases indicated by a considerable difference in the diameter (Pl. VIII. figs. 8, 9).

Stratigraphy.

These obscure fossiliferous remains are of so restricted a character that they present little evidence as to their geological age. Although representing the first fossils from the Matabeleland deposit, as stated by Mr. Maufe, it is of interest to note that Dr. A. W. Rogers* has referred to a similar occurrence in the "Surface quartzites" of Cape Colony (near Komgha Village, N. of East London), which have yielded silicified seeds of *Chara* associated with silicified shells of *Limnæa*, and regarded as of Tertiary age. Again, minute *Chara* fruits occur in a hard cream-coloured limestone which Mr. Beadnell discovered some years since in the Northern Fayûm of Egypt, a small fragment of which is in the Geological Department of the British Museum. It was collected when Mr. Beadnell was on the staff of the Geological Survey of Egypt, being included in his manuscript list of fossils from

* 'An Introduction to the Geology of Cape Colony,' 1905, p. 360; and second edition, 1909, p. 381.

that region, but subsequently omitted its occurrence when writing his memoir on the geology of the Fayûm *. That rock contains no other fossils in association, although according to the MS. list the molluscan genera *Melania*, *Planorbis*, and *Unio* were found in the same series of beds which were horizoned as Lower Oligocene or Bartonian. The Egyptian fruits are rather rounder than those of the Central African rock, being probably more closely related to those of the Oligocene deposits of Britain and Europe. A somewhat similar association of organisms occurs in the rocks of the Sichel Hills and Nagpur regions of Central India, which are recognized as of Uppermost Cretaceous age. Those deposits, often highly siliceous or chalcedonic, contain *Chara* (*C. malcolmsoni*) and freshwater mollusca, and were first noticed by Malcolmson †, his fossils being described by J. de C. Sowerby, while the material more particularly from the Nagpur country was later monographed by Hislop and Hunter ‡. The smaller Gastropods referred to by these authors under the familiar name of *Paludina*, but belonging to the genera *Viviparus* and *Paludestrina*, may claim some resemblance to the present African specimens, especially to J. de C. Sowerby's *Viviparus* (*Paludina*) *deccanensis*, and the so-called *Melania hunteri* of Hislop which is here considered to belong to *Paludestrina* §. These Indian rocks, known as the Intertrappean beds of the Deccan Trap series, are likewise full of a large *Physa* (*P. prinsepii*), besides Unioniform and other shells, as well as numerous Ostracodiform Crustaceans, all of which are entirely absent in the new African material. Malcolmson and Sowerby referred such beds to the Tertiary period, while Hislop and Hunter recognized them as Lower Eocene. Neumayer‖ subsequently studied the same Mollusca from the writings of the English authors, and pointed out their close relationship to forms characterizing the Laramie Beds of North America belonging to the topmost Cretaceous; hence to that age he ascribed this extensive formation of India, a result which has long been accepted by the Geolo-

* 'The Topography and Geology of the Fayûm Province of Egypt,' Survey Department, Cairo, 1905.

† Trans. Geol. Soc. London, 1840, ser. 2, vol. v. pls. xlvi., xlvii. pp. 537–575.

‡ Quart. Journ. Geol. Soc. London, 1860, vol. xvi. pp. 166–176, pls. v.–vii.

§ Quite recently Col. H. H. Godwin-Austen, F.R.S., has urged the necessity of a generic revision of these Deccan Trap Mollusca: 'Records Indian Mus.' 1919 (October), vol. xvi. part vi.

‖ 'Records Geol. Surv. India,' 1884, vol. xvii. pp. 87, 88 [=a translation from Neues Jahrb. 1884, vol. i. Briefl. Mitt. pp. 74–76].

gical Surveyors of that country. More recently Mr. E. W. Vredenburg * has added further confirmation of this late Cretaceous age for the Indian deposits by referring to the occurrence of *Physa prinsepii* in the Maestrichtian strata of Baluchistan associated with the Ammonite, *Sphenodiscus ubaghsi*. Grossouvre, accounting for the freshwater Gastropod as having been washed out of a neighbouring estuary during the deposition of the marine Ammonite-rocks. The probability of this correlation of the Indian beds with the Laramie group seems also to be demonstrated by the occurrence in both of Dinosaurian reptiles, for it is known that the Lameta deposits forming the lowest part of the Intertrappean series of India have yielded *Titanosaurus* † in supposed association with *Physa prinsepii*, as also, according to Hislop ‡, with *Viviparus deccanensis* and other shells common to those Indian rocks. It is of interest to note that *Titanosaurus* and further Dinosaurs have been also described from the Upper Cretaceous deposits of Madagascar (around Mevarana) by M. C. Depéret §, but with no record of their association with fluvio-lacustrine mollusca or plant-life. No *Chara* relics are known from the true Laramie group, although Mr. Knowlton ‖ has described *C. stantoni* from the Bear River deposits of the United States which he regarded as of Laramie age, but which Mr. Stanton ¶ believes to be older, and of an age nearer the base of the Upper Cretaceous,—probably between the Cenomanian and Turonian, as judged by the European standard of stratigraphy. G. R. Wieland ** also supports an Upper Cretaceous age for the Bear River Beds, although recognizing them as older than the Laramie. Again, a faunistic resemblance has been pointed out among the fossils of the Belly River deposits of Canada and those of the opalized beds of New South Wales ††, both of which exhibit an estuarine facies, as they contain Plesiosaurian and Dinosaurian remains as well as freshwater and marine mollusca and other organisms, while such deposits are referred to the Uppermost Cretaceous. In estimating the importance of

* 'Records Geol. Surv. India,' 1907, vol. xxxv. pp. 114-118.

† Lydekker, 'Records Geol. Surv. India,' 1877, vol. x. p. 38; and R. D. Oldham's edition of Medlicott and Blanford's 'Manual of the Geology of India,' 1893, pp. 264, 265.

‡ Quart. Journ. Geol. Soc. 1864, vol. xx. pp. 280–282.

§ Bull. Soc. Géol. France, 1896, ser. 3, vol. xxiv. pl. vi. pp. 176–191.

‖ 'Botanical Gazette' (Indiana), 1893, vol. xviii. p. 141.

¶ American Journ. Sci. 1892, ser. 3, vol. xliii. pp. 98–115.

** Mon. United States Geol. Surv. 1905, vol. xlviii. p. 208.

†† R. Bullen Newton, Proc. Mal. Soc. London, 1915, vol. xi. pl. vi. pp. 217–235.

these facts, it would seem possible that this African formation, with its freshwater assemblage of organisms, would appear to favour a correlation with the Intertrappean beds of India, and consequently would be Upper Cretaceous. Such a result is in support of the now generally received view of the existence of a land-connexion between India and Africa during the Cretaceous epoch. Moreover, palæontological researches support the theory of such a land-surface being continuous from Upper Palæozoic times, and so uniting Australia, India, Madagascar, Africa, and America—a stretch of territory known as Gondwana Land, which has yielded the celebrated *Glossopteris* flora *. At the close of the Cretaceous epoch this great land-area was broken up, and finally became submerged by the invasion of the Tertiary Sea †.

Conclusions.

This chalcedonized rock from Matabeleland is mentioned by Mr. Maufe as occurring in a peneplain of Upper Karroo Beds and at the base of Pleistocene deposits known as the Kalahari Sands, which in this region of Africa mostly cover the basalts and the other underlying formations. Dr. Passarge ‡ has described similar rocks to the south in the Kalahari country under the group-name of "Botletle Schichten," and later Mr. G. W. Lamplugh § recognized the same deposits in the Batoka Gorge of the Zambesi River, and termed them "Chalcedonic Quartzite." No definite geological age has been assigned to this formation, on account of the absence of palæontological evidence, although Dr. Passarge has attempted a divisional sequence of the beds as they occur in the Kalahari Desert, involving certain climatal conditions, the oldest of the beds being regarded as Eocene.

It is important also to again mention the presence of similar beds made known to us under the name of "Surface Quartzites" by Dr. A. W. Rogers, containing both *Chara* and *Limnæa*, occurring in the South-eastern area of Cape Colony, thus proving fairly conclusively a contemporaneity of deposition with the chalcedonic rocks of Matabeleland, the Zambesi territory, and Kalahari.

It is now suggested, from an examination of the obscure

* E. A. N. Arber, "On the Distribution of the *Glossopteris* Flora," Geol. Mag. 1902, pp. 346–349.

† See Mr. R. D. Oldham's remarks on this subject in his edition of Medlicott and Blanford's 'Manual of the Geology of India,' 1893, p. 211.

‡ 'Die Kalahari,' 1904 (Berlin), pp. 196, 285, 648.

§ Quart. Journ. Geol. Soc. 1907, vol. lxiii. p. 198.

fossils referred to in the paper, that this African formation, extending from the Zambesi country to Cape Colony, may be older than Eocene, and that its occurrence in a basaltic region comparable to that of the Deccan Trap country of Central India may point to a similar horizon for its deposition, viz., Upper Cretaceous. The assemblage of organisms found at present in the African rock is admittedly very small, but, so far as it goes, it seems to offer resemblances which would associate it in time with that characterizing the Intertrappean beds of India. It is to be hoped that additional specimens may be forthcoming which might help to confirm these stratigraphical suggestions, and so to strengthen the view that these chalcedonized deposits may represent part of the land-platform which united Africa with India during Cretaceous times.

EXPLANATION OF PLATE VIII.

Gastropoda.

Fig. 1. (A) *Viviparus* and (B) *Paludestrina* ?. Dorsal views of surface-specimens, × 8. No. 1352. [Fig. 1 B has been intensified.]

Fig. 2. *Viviparus*; microscopical transverse section from near the base of a specimen. × 7. No. 1351.

Fig. 3. *Paludestrina* ?, dorsal view, × 8. No. 1352. A surface-specimen embedded in rock. [Figure intensified.]

Plantæ.

Fig. 4. *Chara* stems as seen on the rock-surface, exhibiting typical longitudinal flutings and obscure transverse jointings, × 7. No. 1352.

Fig. 5. A *Chara* fruit or oogonium of comparatively large size, exhibiting strong spiral ridges, embedded in a matrix cavity, × 7. No. 1352.

Fig. 6. A surface-series of *Chara* fruits and cavities of minute size in longitudinal arrangement, with microscopically fine spiral striations, × 5. No. 1350.

Fig. 7. A *Chara* stem cut transversely, as seen in a microscopical section of rock, showing the existence of about fourteen tubular apertures encircling the large central canal, × 8. No. 1351. [Figure intensified.]

Fig. 8. A group of transversely cut *Chara* stems, as seen in a microscopical section of rock exhibiting similar structures to the foregoing, × 10. No. 1352.

Fig. 9. *Chara* stems in transverse section, as seen in a microscopical preparation of rock showing an oval form with indications of the cortical cells, × 20. No. 1352.